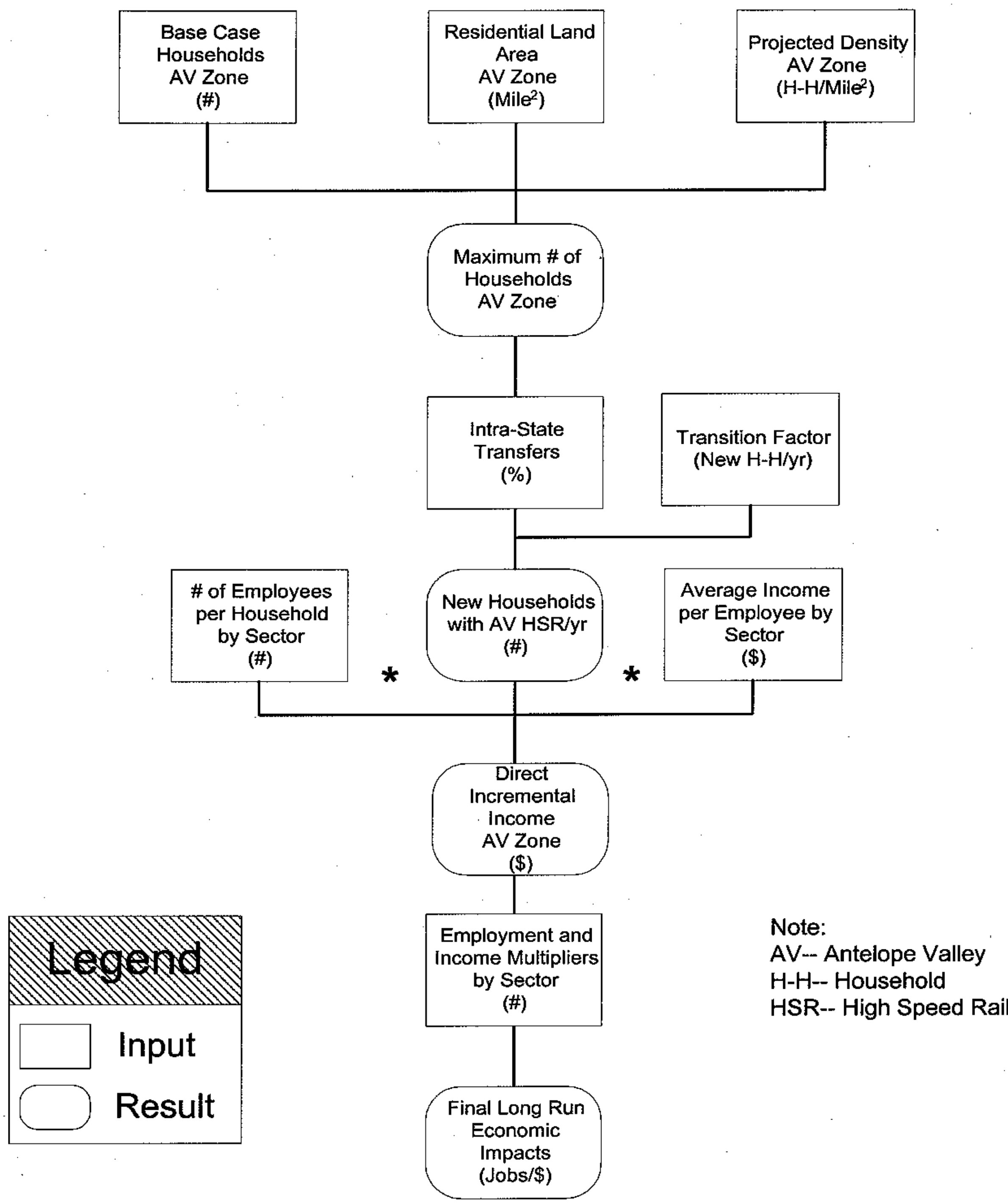
APPENDIX 7: HLB ECONOMIC SIMULATION MODEL, STRUCTURE AND LOGIC FOR THE ESTIMATION OF LONG-RUN IMPACTS

Figure 12: Structure and Logic Diagram for the Estimation of Long-Run Impacts


Base Case Households AV Zone (#)
Residential Land Area AV Zone (Mile²)
Projected Density AV Zone (H-H/Mile²)
Maximum # of Households AV Zone
Intra-State Transfers (%)
Transition Factor (New H-H/yr)
# of Employees per Household by Sector (#)
New Households with AV HSR/yr (#)
Average Income per Employee by Sector ($)
*
*
Direct Incremental Income AV Zone ($)
Employment and Income Multipliers by Sector (#)
Final Long Run Economic Impacts (Jobs/$)
Legend
Input
Result
Note:
AV-- Antelope Valley
H-H-- Household
HSR-- High Speed Rail

APPENDIX 8: BRIEF OVERVIEW OF RISK ANALYSIS

The risk analysis of any projection involves rigorous analysis and expert scrutiny of the variables and assumptions that influence its outcome. The result of a risk analysis is a forecast of future events and the probability, or odds, of their occurrence. Not unlike modern weather forecasting, where the likelihood of rain is projected with a statement of probability ("there is a 20 percent chance of rain tomorrow"), risk analysis provides decision makers with a sense of perspective on the likelihood of future events.

Risk analysis develops this information from a probability assessment of all underlying assumptions. The process is an easily understandable, transparent but technically robust method that allows decision makers to select acceptable risk levels for planning and making resource commitments.

The further into the future projections are made, the more uncertainty there is and the greater the risk is of producing forecasts that deviate from actual outcomes. Projections need to be made with a range of input values to allow for this uncertainty and for the probability that alternative economic and demographic conditions may prevail. The difficulty lies in choosing which combinations of input values to use in computing forecasts and how to use those forecasts to produce a final estimate.

Forecasts traditionally take one of two forms: first, a single "expected outcome", or second, one in which the expected outcome is supplemented by alternative scenarios, often termed "high" and "low" cases. Both approaches fail to provide adequate perspective with regard to probable versus improbable outcomes.

The limitation of a forecast with a single expected outcome is clear -- while it may provide the single best guess, it offers no information about the range of probable outcomes. The problem becomes acute when uncertainty surrounding the underlying assumptions of the forecast is especially high.

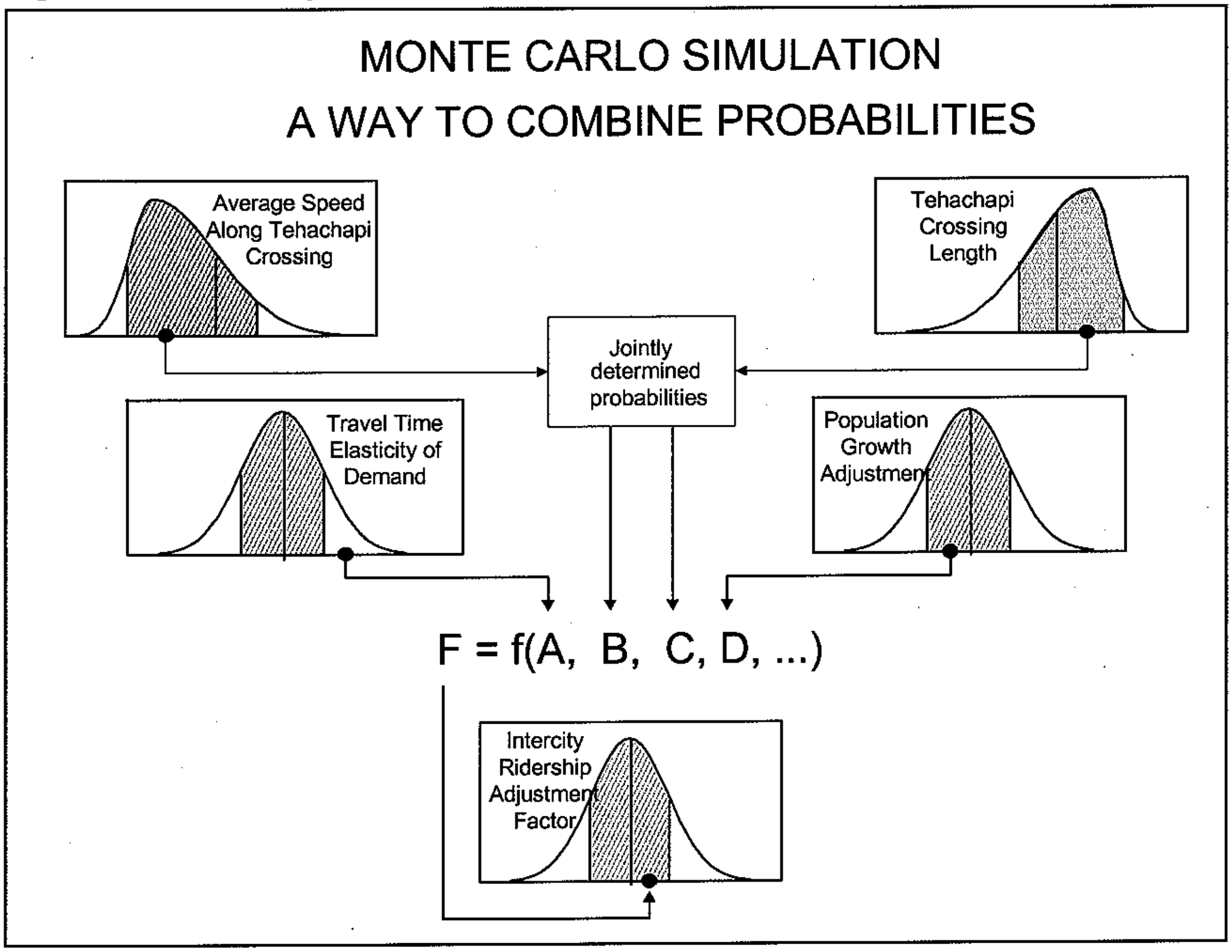
The high-low approach can actually exacerbate this problem. It gives no indication of likelihood that the high and low cases will actually materialize. Indeed, the high case usually assumes that most underlying assumptions deviate in the same direction from their expected value; and likewise for the low case. In reality, the likelihood that all underlying factors shift in the same direction simultaneously is just as remote as everything turning out as expected.

A common approach to providing added perspective on reality is through "sensitivity analysis", whereby key forecast assumptions are varied one at a time to assess their relative impact on the expected outcome. The problem is that the assumptions are often varied by arbitrary amounts. A more serious flaw in this approach is that in the real world, assumptions do not veer from actual outcomes one at a time; it is the impact of simultaneous differences between assumptions and outcomes that provides true perspective on a forecast.

The result of a risk analysis is both a forecast and a quantification of the probability that the forecast will be achieved.

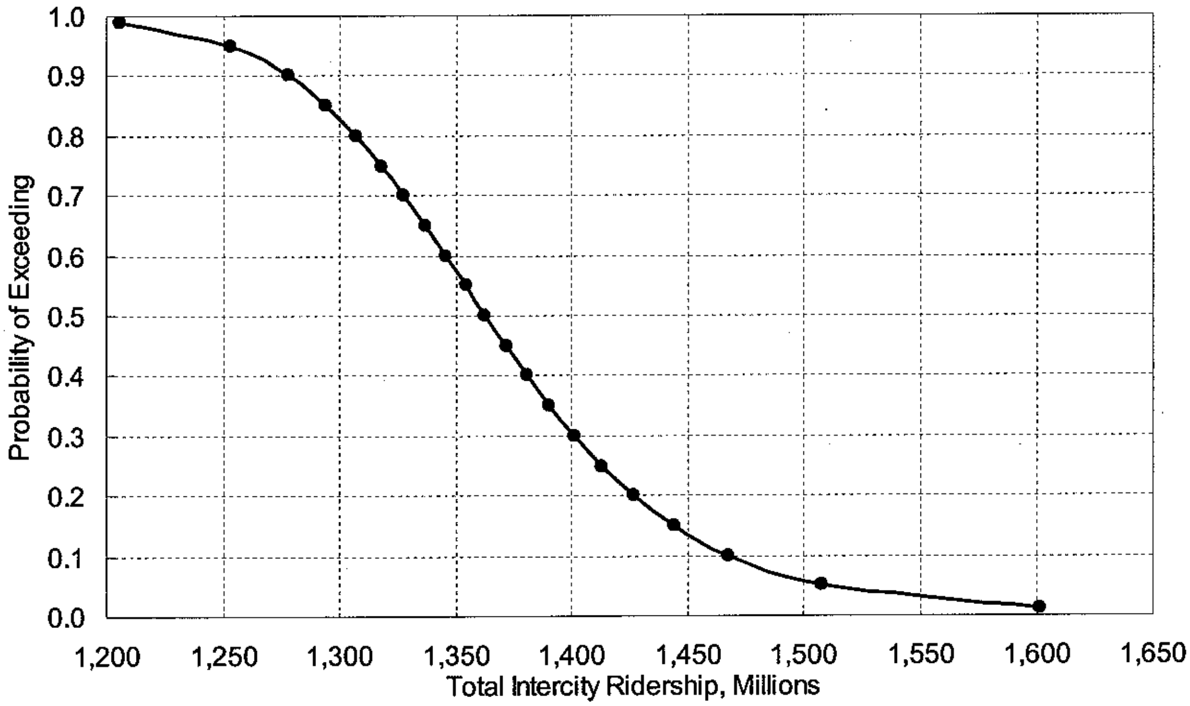
Risk Analysis provides a way around the problems outlined above. It helps avoid the lack of perspective in "high" and "low" cases by measuring the probability that an outcome will actually materialize. This is accomplished by attaching ranges (probability distributions) to the forecasts of each input variable. The approach allows all inputs to be varied simultaneously within their distributions (through Monte Carlo simulations), thus avoiding the problems inherent in conventional sensitivity analysis. The approach also recognizes interrelationships between variables and their associated probability distributions. This is illustrated in Figure 13 below.

Figure 13: Risk Analysis, An Illustration



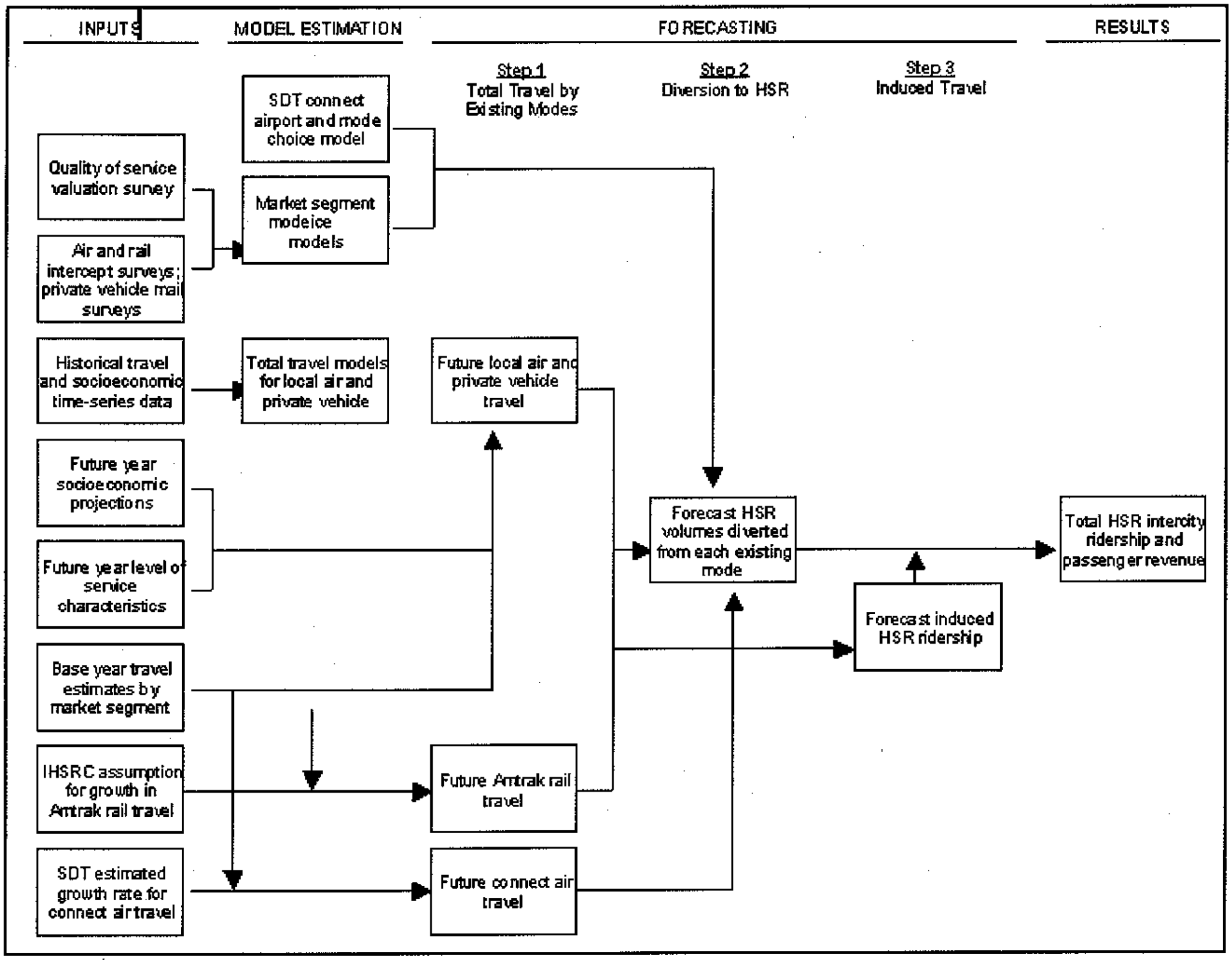
The result of a risk analysis simulation is a forecast that includes estimates of the probability of achieving alternative outcomes. Each output variable can be displayed as a graph. The decumulative graph on the next page, for example, shows total intercity ridership (along the x-axis) and the probability of exceeding those ridership levels (along the y-axis).

Figure 14: Risk Analysis Results, An Example



APPENDIX 9: FORECASTING MODEL STRUCTURE

Figure 15: Authority's Model Overview



City of Palmdale

Financial and Economic Performance of the Antelope Valley High Speed Rail Alignment

An Update

December 2, 1998

FINANCIAL AND ECONOMIC PERFORMANCE OF THE ANTELOPE VALLEY HIGH SPEED RAIL ALIGNMENT- AN UPDATE

Prepared By:
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December 2, 1998
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ABSTRACT

The Antelope Valley high speed rail alignment offers greater value for money than an alignment over the Grapevine Pass.

This conclusion stems from a comparative assessment and risk analysis of alternative alignments in relation to projected ridership, capital costs, transportation benefits, economic development, and commuter rail operations. Compared with the Grapevine Pass alignment, the Antelope Valley alternative would:

- *Generate $500 million more state-wide economic development.*
- *Promote significantly more use of commuter rail between Los Angeles and Palmdale, thereby reducing congestion and increasing economic development in the Los Angeles region.*
- *Although the conclusions outlined above assume the technical feasibility of five percent grades in the design plan for the Grapevine Pass alignment option, the implications of five percent grades for system maintenance, safety and operations have yet to be proven in revenue service. Adopting the proven design standard (a maximum 3.5 percent grade) would add fully $100 million in tunneling cost to the Grapevine Pass alignment option and add further strength to the comparative advantages of the Antelope Valley option.*

EXECUTIVE SUMMARY

Adopting the Antelope Valley high speed rail alignment promises greater value for the money than an alignment over the Grapevine Pass. This finding emerges from comparative assessments in relation to ridership, capital costs, net transportation benefits, economic development impacts in the State of California, and commuter rail effects.

This study reports an 80 percent probability that economic development associated with the Antelope Valley alignment would exceed economic development benefits associated with the Grapevine Pass alignment by almost $500 million.

Overview

California is continuing to explore a viable high speed rail alternative that will link the northern and southern population centers of the state. Previously, between 1994 and 1996, the California High Speed Rail Commission conducted preliminary studies of ridership, costs and other issues pertaining to the realization of high speed rail in California. Teams of consultants studied each issue independently and an initial alignment for high speed rail was drawn from a synthesis of their studies. The synthesis proposed that the high speed rail alignment cross the Central Valley via the Grapevine Pass due to "average" or "best guess" situations that showed it to have higher forecast revenues and lower costs.

In 1996, the City of Palmdale engaged Hickling Lewis Brod Inc. (HLB) to independently examine whether the consultants' studies indeed supported the Grapevine Pass alignment, or, if there was an economic and financial case to be made in support of the alternative Antelope Valley alignment. HLB demonstrated that when factoring the risks implied in the consultants' studies, and, when considering the economic development impacts, the Antelope Valley alignment was in fact superior. The Commission accepted these conclusions, deciding by a 5-4 vote in favor of the Antelope Valley alignment (See Exhibit O for the commission recommendations). The alignment alternatives are presented in the Commission's Summary Report and Action Plan of 1996.

Under its current mandate, the California High Speed Rail Authority is conducting further study that will include a renewed examination of the alignment alternatives. In anticipation of the approaching discussion of the alternatives, this report revisits the 1996 Study by HLB.

Scope of The Report

This report examines the published documents of the California High Speed Rail Authority and other sources, addressing the issues associated with the choice of alignment. The analysis here represents an update of the 1996 HLB study and incorporates the most recent regional demographic and economic outlooks.

The report examines four aspects of the published studies and their effect on the economic value of alternative alignments:

- Ridership forecasts -- results, forecast error, and underlying assumptions;
- Factors contributing to uncertainty in alignment cost estimates;
- Commuter rail potential and its impact on HSR's economic viability; and,
- Economic development impacts.

This report examines factors which extend beyond the specific mandate of the High Speed Rail Authority but which are nonetheless legitimate in an economic analysis. These factors include ridership between cities which are less than 80 miles apart, the integration of high speed rail with the development of the state's commuter rail system, and economic development benefits. Failure to include these factors in earlier analyses was a source of bias in arriving at an economically preferable alignment through the Central Valley.

Due to uncertainty in infrastructure planning, risk analysis techniques were used in this report to quantify uncertainty explicitly. When examining the cost and benefit aspects of HSR alternatives, risk-adjusted outcomes are crucial to a process of informed decision making.

Principal Findings

Our analysis shows that the studies support a high speed rail alignment through the Antelope Valley rather than through the Grapevine Pass. The Antelope Valley alignment is seen to be superior to the Grapevine Pass alignment both in terms of ridership and net economic benefit to the state and its citizens.

Ridership Forecasts and Informed Decision-Making

Current ridership forecasts indicate that adding the Antelope Valley to the high speed rail system in California would result in the loss of approximately one million passengers[1], or nine percent of total ridership. This nine percent decrease in total ridership is caused primarily by a ten minute increase in total travel time (less than five percent of total trip time). Several key features of the ridership forecasting model point to the inappropriateness of making definitive judgments on the relative ridership estimates of alternative high speed rail alignments. These features and their impact on alignment choice are as follows.[2]

- *Forecast Margin of Error.* Ridership forecasts contain margins of errors attributable to the following sources:
  - ⇒ The statistical robustness of the model;
  - ⇒ The gap between forecast assumptions and the sample used in estimating the model; and

[1] See Charles River Associates *Ridership Study*, Table 6-8.
[2] A complete discussion of the model features and their impact on ridership estimates is provided in Section 2 of the main body of the report.

⇒ Uncertainty surrounding the forecast assumption itself.

With the forecast horizon of 20 years, there is no ridership forecasting model which can claim accuracy -- even with "certain" forecasting assumptions -- within 20 percent. Forecasting models are useful in choosing between alternatives when outcomes differ by an order of magnitude which is larger than the forecast margin of error. However, as in the case of the Central Valley alignment alternatives, the slight difference in the forecast ridership is not sufficient to support a decision preferring one alternative over another.

- *Induced Demand.* Underestimation of induced demand (trips which would have been taken in the absence of high speed rail) is biased against regions with relatively shorter trip times and costs (i.e., Antelope Valley).

- *Absence of Short Haul Intercity Trips.* The demand forecasting model is structured to account for trips with a minimum distance of eighty miles. This model specification underestimates total ridership by not accurately measuring origin-termination trips of less than eighty miles (Palmdale Station - LA 71 miles).

- *Low Value of Access Time.* Underestimation of access and egress costs leads to an overestimation of the potential riders from the Antelope Valley region that will be retained in the absence of a Palmdale station.

The above issues, when combined, indicate a different set of conclusions than those reached by the initial synthesis report that was prepared in 1996 and was the basis for the Commission's initial alignment decision. If these issues, and the quantitative evidence supporting them, are used to develop a risk assessment of the range of potential outcomes, then the Antelope Valley alignment clearly becomes comparable with the Grapevine Pass alignment. The risk assessment in this report shows that even under conservative assumptions affecting ridership, there is a fifty percent likelihood that the Antelope Valley alignment will generate at least 125,000 more riders per year than the Grapevine Pass alignment. Furthermore, there is only a ten percent probability that the Antelope Valley alignment would cause a loss of riders of more than 400,000 per year -- less than half the number that was anticipated by the ridership study.

Cost Uncertainties and their Impact on Alignment Choice

Besides ridership and revenue, the capital investment in high speed rail is a key determinant of the project benefit-cost. This report identifies the greater risks associated with the capital costs for the Grapevine Pass alignment. When these risks are taken into account, there is no cost basis for preferring the Grapevine Pass over the Antelope Valley alignment.

Initially, Commission reports concluded that the expected difference in capital costs between the two alignments is $540 million with $2.42 billion in expected total costs for the Grapevine Pass and $2.96 billion in total costs for the Antelope Valley alignment. While the cost per mile is estimated to be less for the Antelope Valley alignment than for the Grapevine Pass ($25 million versus $30 million), it is longer by approximately 37 miles, which accounts for the difference in total costs.[3] The higher capital costs per mile are an indication of the difficulties associated with the mountainous terrain in the Grapevine Pass portion of the high speed rail line. These difficulties are compounded by the risk factors that are unique to this alignment.

The riskiness of the project's capital cost estimates have several sources, namely:

- *General Uncertainty.* Most capital cost estimates include a contingency factor to account for all underlying uncertainty and to protect against potential overruns. These contingency factors range between ten and twenty-five percent. The difference between the two alignments (1% of total costs[4]), is within the planning level for contingencies.

- *Tunneling.* The Grapevine Pass alignment has considerably more tunneling than the Antelope Valley alignment. Tunneling is one of the most sensitive cost components to uncertainties, delays, and cost overruns and is the distinguishing feature between the two alignments. As such, the uncertainties associated with the Grapevine Pass alignment are greater than the Antelope Valley (Exhibit I).

- *Environmental Issues.* The Grapevine Pass alignment is noted in the Commission reports as having larger potential negative environmental impacts than the Antelope Valley alignment. This is directly related to the impact of tunneling and contributes to the overall risk associated with the Grapevine Pass cost estimates (Exhibit I).

This report provides a risk assessment of the capital costs for the alternative alignments and shows that the expected value of the incremental cost associated with the Antelope Valley alignment is $419 million. However, if the risks associated with the capital cost estimates are accounted for, the analysis shows that there is a 15 percent probability that the cost of the Antelope Valley alignment would be less than the Grapevine Pass alternative.

Ridership and Cost Estimates and their Impact on Cost-Benefit Results

The Commission produced a benefit-cost evaluation of high speed rail in California. The commission considers only the base case alignment, the emphasis was placed on the comparison of technology alternatives (VHS versus Maglev) and the benefits of the high speed rail extensions, rather than on alignment alternatives. As such, no direct evidence is available on the two alignment alternatives as to their relative "net benefits" (Exhibit C).

Notwithstanding the lack of direct evidence, the risk assessment of both the ridership and capital cost estimates provide strong indications of the outcome of a comprehensive benefit-cost evaluation.

The reports prepared for the Commission adopted standard benefit-cost analysis techniques that are used in the evaluation of transportation investments.[5] With these techniques, the benefits of

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[3] The California Intercity High Speed Rail Commission (1996), *Summary Report.* Table 8-13.
[4] The California Intercity High Speed Rail Commission (1996), *Summary Report.* Table 8-13.
[5] Wilbur Smith and Associates (1996), *High Speed Rail Economic Benefit/Cost Evaluation: California HSR Economic Impact,* The California Intercity High Speed Rail Commission. Working Paper 11. This report also

high speed rail derive primarily from forecast rail ridership and the relative costs of alternative modes of travel. If travelers are shifted from more costly modes to high speed rail then there is a benefit to the economy. The present value of these benefit flows over the planning horizon of the project less the present value of costs represent the net benefit (benefit-cost) of the project.

The risk assessment of ridership and capital costs shows that there is a strong likelihood that the Antelope Valley alignment may be favorable in both the cost and benefit aspects. Given the direct link between ridership, capital cost estimates and net benefits, it is also likely that the net benefits from the Antelope Valley alignment may exceed those of the Grapevine Pass. While the studies indicate that this is indeed the case, the validation of this finding requires a comprehensive risk and benefit-cost analysis of the high speed rail alternatives.

Impact of Commuter Rail Potential on Alignment Choice

Although the Commission was tasked with an evaluation of the intercity potential for high speed rail in California, that potential is closely linked to the state's commuter rail potential which has been studied in a separate Commission study. This study looked at two "prototype routes" serving San Francisco and Los Angeles. The two routes serving Los Angeles were Bakersfield to LA with one route serving Palmdale station and the other going directly from Bakersfield to Santa Clarita. (See Exhibit E)

The commuter rail study shows that the addition of the Palmdale station adds approximately one million passengers per year to the Bakersfield-LA direct routing through Santa Clarita. This represents an increase of 37 percent over the base potential commuter ridership from Bakersfield to LA. Without the high speed rail link to Palmdale station for intercity trips this potential is lost thus weakening the overall outlook for a statewide rail system, commuter and high speed rail alike.

Economic Development and Alignment Choice

An additional factor supporting the Antelope Valley alignment is the potential for high speed rail to generate short and long term economic development impacts. The economic, demographic and physical characteristics of the Antelope Valley community are poised to take advantage of HSR-based economic development activity in the state of California (See Exhibit A).

This report considers three components of the likely economic development impact of high speed rail in the Antelope Valley. The first estimates high speed rail's contribution in attracting individuals and families to the Antelope Valley which is one of the few regions in the greater Los Angeles area which can support residential and industrial growth. The second component is the direct and indirect economic impacts associated with high speed rail station development at the Palmdale airport. The third evaluates the potential for the Antelope Valley alignment to either retain or attract new industry to the state of California. Table ES 1 summarizes the findings on economic development impacts.

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includes an analysis of operating surplus (deficit). We assume for this discussion that similar ridership estimates generate roughly similar operating income results.(See Exhibit Q)

The table shows that the economic development impacts are expected to be $318 million. With eighty percent confidence the economic development impacts will lie between $190 million and $479 million. The report estimates total economic benefits using notional values for manufacturing activity, which, given current manufacturing growth forecasts for the region, could be significantly higher. All of these economic benefits to the state of California hinge upon the Antelope Valley alignment and the Palmdale station.

Under conservative assumptions, the economic development potential from high speed rail in the Antelope Valley far outweighs the possible incremental increase in capital costs.

Table ES 1 - Economic Development Impacts for the state of California with Antelope Valley Alignment

Economic Development Component	Median	Lower 10%[a]	Upper 10%[a]
Long Run Development Impact - Residential Growth due to Access (millions)[b]	$199	$85	$340
Commercial Development Impact (millions)[c]	$87	$82	$92
Manufacturing Impact (millions)[d]	$10	$5	$20
Short Term Impact Station Investment ($ millions)[b]	$22	$18	$27
Total	$318	$190	$479

a - These values represent probability ranges and are not strictly additive. b - HLB estimates. c - HLB estimates based on ERA Economic Impact study for the Commission. Assumes 50% of ERA estimate absorbed in the state economy. d - Notional values.

Conclusion

The shaded column in Table ES 2 shows the results of the risk analysis for the two high speed rail alignment alternatives. From the perspective of net transportation benefits, the tradeoff between risk and yield indicates no clear preference for either alignment. In fact, the analysis of the ridership and capital costs shows a strong probability that the Antelope Valley alignment could be more favorable in both respects.

When the analysis is expanded beyond the impacts covered in the Commission reports, the Antelope Valley alignment emerges as the superior alignment in terms of total net benefits. The estimated economic development benefits for the state of California with the Antelope Valley alignment are between $190 million to $479 million. The net benefits from an integrated commuter rail system are between $5 million to $10 million.[6]

The economic development and commuter rail impacts, coupled with the risk analysis results for ridership and capital costs, show that the Antelope Valley alignment could generate higher total benefits for California. Failing to recognize the potential benefits of high speed rail in the Antelope Valley compromises the overall viability of the system.

[6] This range corresponds to an eighty percent confidence interval.

Table ES 2 - Summary of Risk Analysis of Antelope Valley High Speed Rail Alignment, in Dollars of 1995 Purchasing Power

Indicator	**Antelope Valley Compared to Grapevine Pass**
	Risk Analysis Results
Ridership Difference in 2015	80% Probability Range -400,000 to +700,000
Capital Cost (Million)	80% Probability Range -$70 to +$882
Net Transportation Benefits of HSR	No Statistical Difference
Economic Development Impacts of HSR (Million)	80% Probability Range +$190 to +$479
Net Transportation Benefits of HSR with Integrated Commuter Rail (Million)	80% Probability Range +$5 to +$10
Total Net Benefit	**Strong Probability of Greater Total Net Benefits**

Source: HLB estimates based on HLB risk analysis and California Intercity High-Speed Rail Commission, (1996), *Summary Report and 20 Year Action Plan.*
NC-- Not considered.

1. INTRODUCTION

The economic vitality and stability of California has depended historically upon the ability of people and goods to move freely and efficiently between its population centers, agricultural markets, and international ports of entry. This is true not only for the principal cities of Los Angeles, San Francisco, and San Diego but also for their respective metropolitan regions and for the great Central Valley. A valid question is whether the highway and air travel systems that have served the state so well in the past can continue to maintain the degree of mobility necessary for continued economic growth and stability. Even with incremental capacity enhancements to the intercity highways and airports, it is likely that the historic functionality of these systems can not be maintained at levels necessary to support anticipated population growth and travel demand. High-speed rail offers a complementary mode to air and highway which will provide the state with a substantially greater degree of intercity mobility in the future. As a major infrastructure investment, the success of high speed rail and the state's ability to maximize benefit from it will depend, to a large extent, upon judiciously choosing its alignment. The alignment choice needs to balance considerations of the overall system's viability; its ability to serve the major travel markets; and, its integration with a sustainable development vision for the state.

In 1996 HLB conducted an assessment and risk analysis the high speed rail alignment alternatives through the Central Valley, with particular focus on the Grapevine Pass and Antelope Valley alternatives. The assessment, based upon studies by consultants for the High Speed Rail Commission, found that the Antelope Valley alignment was the route most likely to maximize the net benefits of high speed rail for California. The study also concluded that the potential for high speed rail to foster economic development benefits in the Antelope Valley are considerable, even in the most conservative case.

This report revisits the 1996 HLB report and examines recent trends and newly developed economic data. In addition, this report reviews and integrates collateral studies, plans, forecasts and technical developments. The review includes MPO and other state, regional and local plans and underlying economic and demographic forecasts. California's population is projected to grow from the current 32.7 million to 48.8 million by 2020, a 49 percent increase (Exhibit A shows the population and employment growth in the state). In the inland valleys (the Inland Empire, the Antelope Valley, and the Central Valley) in particular, the local authorities forecast strong growth.

The Antelope Valley high speed rail alignment encompasses one of the fastest growing communities in California and in the United States. This region has experienced average annual population growth in excess of 15 percent from 1983-1996 coupled with a doubling of personal income per capita over the same time period. Based on SCAG forecast North LA County will experience a population growth of 169% between 1994 and 2020. (See Exhibit A). This growth far exceeds other communities in California and is on a par with the fastest growing regions in the United States.

The Antelope Valley alignment was considered by the California high-speed rail commission as a potential routing for the San Francisco to Los Angeles Corridor. Based on findings from preliminary studies[7], the California Intercity High-Speed Rail Commission (the Commission) initially preferred the State Route 99 Corridor (SR99) through the Central Valley, via the Grapevine Pass.

The Commission's initial decision was based on a preliminary analysis of high speed rail ridership and costs of the Antelope Valley alignment, which included the Palmdale airport station. A cost-benefit analysis was carried out only for the SR99/Grapevine corridor (see Exhibit C).

This report analyzes the alignment decision, using readily available data, and shows that ridership and cost estimates do not conclusively support elimination of the Antelope Valley alignment from further consideration. Furthermore, this report concludes that the benefits of the Antelope Valley alignment which were not considered by the Commission. Economic development impacts and commuter rail potential support the selection of the Antelope Valley alignment over other alternatives.

1.1 Background

When considering transportation infrastructure investments, decision-makers often consider a wide range of alternatives. Cost-benefit analysis provides economic criteria for the consideration of alternative infrastructure investment strategies. However, in many cases cost-benefit analysis and all of its components require extensive resources which are often not justified for each and every alternative. It also outlines the principle screening methodologies and their merits and interrelationships. This approach limits the need to conduct a thorough cost-benefit analysis for each alternative, while at the same time ensuring that viable alternatives will not be excluded from further consideration.

1.1.1 Stakeholder Support

Often the first test of an alternative's viability is whether an approach has considerable support from stakeholders based on their intuitive judgments that a project is desirable. Stakeholders concerned about high speed rail alternatives include a wide range of individuals, public and elected officials at all levels of government, transportation engineers and planners, economic development experts, community groups, business groups and industry analysts. It is often the support of stakeholder groups which give transportation ideas their first life as practical solutions to transportation problems. While this initial screening process is often better suited to the identification of a particular transportation problem rather than the development of specific and viable options, it has the advantage of reducing an unmanageable set of alternatives to a manageable one at minimal cost.

Public interest and stakeholder support is often wide ranging among alternatives. However, this support is often indicative of a group of individuals' preliminary qualitative, and in some cases

[7] A Cost Comparison of Mode Alternatives by Wilbur Smith Associates.
An Economic Impact Analysis by Economics Research Associates.
A Benefit Cost Comparison by Wilbur Smith Associates.
High Speed Rail Economic Benefit/Cost Evaluation by Wilbur Smith Associates.
Ridership Study by Charles River Associates.

quantitative, assessment that "their" alternative will be the preferred alternative following a more in-depth investigation. An analytic structure is needed so that these preliminary assessments, which are often based on intuition, can be developed into an objective screening criteria which can then be applied to all possible alternatives.

1.1.2 Preliminary Analysis

In many cases, preliminary assessments of alternatives by stakeholders are made based on judgments regarding components of a more thorough cost benefit analysis. Cost-benefit analysis results are reported in net present value terms to provide an indication of a transportation alternative's economic viability. Net present value is the present day value of all costs of a project minus the present day value of all benefits, where the present value of benefits and costs is calculated by applying an appropriate discount rate.[8]

Total costs and benefits are in turn made up of many sub-components. On the cost side, new infrastructure entails engineering and construction costs, land purchase costs and, in the case of high speed rail, additional capital and operating costs for newly purchased trainsets. Benefits are in turn principally driven by the demand for a new transportation service. With knowledge about the components of a more comprehensive cost-benefit analysis, partial analysis can be conducted to screen alternatives.

The nature of such partial or preliminary analysis depends both on the nature of the projects in question and on the framework for the complete analysis. Inevitably, a screening process will involve thoughtful analysis of intermediate measures involved in both cost and benefit estimates. A partial analysis will involve the development of threshold values for these intermediate metrics for the exclusion of a particular option from further consideration. There are several different approaches to utilizing such threshold values. The three principle approaches are discussed below.

1.2 Threshold Values and Partial Analysis

1.2.1 Partial Analysis Based on Rules of Thumb

Threshold values for intermediate metrics are often based on long-standing "rules of thumb" which help guide transportation investment decisions. For instance, a new train service such as high speed rail often requires densely populated urban centers at or near the origin and termination points of a new line. This ensures that sufficient demand will be available to offset the operating costs as well as justify the capital investment. Similarly, on the cost side of the ledger, certain physical or environmental characteristics of a particular transportation option may have cost implications which place it far in excess of budget constraints or which far exceed other alternatives.

1.2.2 Threshold Values and Risk Analysis

Partial analysis, which is based on threshold values for intermediate metrics is best conducted through the use of risk analysis techniques. Risk analysis assigns probability ranges for each

[8] The discount rate measures the rate at which individuals are willing to forego current consumption for future consumption. Discount rates typically range from between 5 and 15 percent for public projects.

factor or intermediate measure being analyzed to consider the uncertainty surrounding preliminary analyses. It also allows for the conduct of counterfactual analysis based on reasoned judgment of probabilities. For instance, risk analysis can be used to determine what the values of intermediate measures would have to be for any given alternative to be preferred. A judgment can then be reached as to what the probability of an intermediate metric having that value is. For each alternative, a probability of being the preferred alternative can be derived, and only those which pass a reasonable threshold, such as 10%, should be further analyzed.

1.2.3 Partial Analysis using Established Mathematical Relationships

Another approach which can be reasonably employed is based on the notion that the mathematical relationship among certain factors makes it possible to eliminate certain alternatives based on a limited number of factors. For instance, if the criteria used to determine the preferred alternative is net present value, then the following formula applies.

NPV = Discounted Benefits - Discounted Costs

The following relationships are then hypothesized.

Benefits = F(X)

Costs = G(Y)

Benefits of any given alternative are a function of some factor x, or set of factors represented by x, which may be measured in a preliminary or partial analysis for any alternative.

Costs of any given alternative are a function of some factor y, or set of factors represented by y, which may be measured, perhaps, in a different portion of the preliminary or partial analysis for any proposed alternative.

If the functions F and G are completely known, then a partial analysis is sufficient to judge the order of magnitude of NPV and rank each of the alternatives. For instance, in a simplified case, suppose the benefits of alternatives A and B are a function of only travel time savings, and travel time savings are known to be 50% higher for alternative A than for B, with approximately 95% certainty. Furthermore, suppose the costs of alternative B are known to be twice the costs of alternative A, with 95% certainty. The ranking of these two alternatives based on net present value criterion is therefore definitive, and alternative B would receive no further consideration.

In practice, the functions F and G are usually not completely known during the beginning phases of the analysis. They depend on factors which may be completely unknown in the early phase of project design and often benefits and costs depend on multiple intermediate measures and indicators. However, if a further assumption is made that the above functions are linear then this analytic framework can be used to screen out some alternatives without eliminating the need to do further analysis on those which remain.

Based on the above equations, the following formula for Net Present Value may be derived.

$NPV_i = F(X_i) - G(Y_i)$

That is, the net present value is the difference between two quantities, each of which are functions of known values.

If F and G are linear than the following formula is true.

$NPV_i = a + f * x_i - g * y_i$

So that the value of NPV for the ith alternative is equal to some constant plus a coefficient of unknown value times some factor x minus a coefficient of unknown value times a factor y, both x and y being known from preliminary analysis.

For example, take two alternatives. The value of x is discerned through preliminary analysis to be greater for the first than for the second. The value of Y is discerned to be less for the first than for the second. It is algebraically certain that the NPV of the first is greater than the NPV of the second. This is then used as the basis for eliminating the second alternative from further rounds of analysis.

While appealing, this line of reasoning has certain weaknesses. First, it assumes that the point estimates for x and y represent 100% certainties. If uncertainty exists about either x or y then the above equation can be used only to develop a probability that one alternative is superior to the other one. Similarly, it assumes that the linear relation is known with certainty. If uncertainty exists as to whether F or G are linear, it may be impossible to demonstrate which alternative is superior. It then becomes necessary to model the relationship in more detail and to establish probability ranges around uncertain parameters. By doing this, we can estimate the probability that one alternative is outranked by another, and whether the inferior alternative passes the threshold for further investigation.

1.3 Application of Screening Criteria in the California High Speed Rail Study

The third analytic framework was implicitly adopted in the California High Speed Rail analysis. The result was the elimination of the option of routing the LA to Bakersfield segment via Palmdale and the Antelope Valley (Exhibit B). The ridership study was then conducted as an initial step in the determination of the feasibility of high speed rail in California. This study suggests lower ridership for a route through the Antelope Valley than for the Grapevine route up I5 to Bakersfield which bypasses Palmdale (See Exhibit D).

The ridership analysis was the primary basis for eliminating the Palmdale route from further consideration. The logic for the elimination of Palmdale seems to be based on the following argument. First, all benefits of high speed rail increase with ridership. Second, revenues and non-user benefits (Exhibit D) also increase with ridership. Therefore, since the Palmdale option generates lower ridership, it necessarily generates lower benefits.

This logic seems to implicitly ignore the cost side of the equation (See Exhibits I and J for Tunneling and Environmental costs), which must also be addressed in order to eliminate an alternative. The mileage for each alternative is known, however, and is slightly longer for the Palmdale alternative. It seems to be assumed that capital and operating costs (Exhibits N and P) increase with mileage and, therefore, costs are higher for the Palmdale route than for the Grapevine route.

The preliminary analysis, although reasonable on its face and logically consistent, is limited by a number of factors. For instance, ridership figures are treated as certainties, despite uncertainties associated with various aspects of demand forecasting for new transportation services (Exhibit D). While point estimates show a very real difference between the demand associated with the Palmdale alternative as compared to alternatives, it may be the case that in probabilistic terms the alternatives are not as distinct from one another. And, there is a basis for questioning whether capital costs necessarily increase with mileage in this case. There are also some larger issues about the scope of the analysis which was undertaken. We will attempt to outline some of these issues below.

2. RIDERSHIP FORECASTS AND THEIR IMPACT ON ALIGNMENT CHOICE

High speed rail ridership estimates produced for the Commission are central to the decision-making process related to alternative high speed rail alignments. With a relatively small difference in capital costs between alignments, the benefits from ridership drive the outcome of the cost-benefit analysis[9] (See Exhibit C).

Prior to the December 1996 Commission recommendations (Exhibit O), the ridership-based decision to adopt the Grapevine pass alignment over the Antelope Valley alignment has been based primarily on the approximately 1 million (9%) difference in total ridership estimates between the alignments (Exhibit D).

This section of the report analyzes the ridership study results to establish the boundaries of the difference in ridership between these alternatives. That is, based on the model structure, assumptions and the statistical significance of the final results, what is the level of certainty associated with this difference in ridership?

The section begins with an overall assessment of the significance of the model results and the appropriateness of using these results to make micro-level decisions. The subsequent sections focus on a number of issues which have a direct impact on the ridership estimates of alternative alignments.

These analyses combined indicate that the distinction between the two ridership estimates, at the aggregate level is highly uncertain, if not negligible. Furthermore, certain model design features and assumptions create a bias against ridership estimates for the Antelope Valley alignment. The section concludes with a set of alternative conclusions which can be derived from the ridership study.

2.1 Overall Assessment of Ridership Model Results

Typical intercity rail demand models have an error range of 20 percent.[10] Even the best model systems that are calibrated using "before" and "after" data have errors associated with them. It is therefore appropriate, whenever using ridership forecasts for decision making, to do so in a risk analysis environment which accounts for this uncertainty.[11]

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[9] The cost-benefit analysis of the Grapevine Pass alignment is provided in Wilbur Smith Associates, 1996, *High Speed Rail Economic Benefit/Cost Evaluation*, California High Speed Rail Commission, Working Paper 11.
[10] *"Signals Model: British rail Analysis of Forecasts for 29 Intercity Rail Investment Programs"*, London, 1985. This study, like the others cited in the footnotes, is used throughout this discussion.
[11] This analysis is based on a review of Charles River Associates, 1996, Independent Ridership and Passenger Revenue Projections for High Speed Rail Alternatives in California, California High Speed Rail Commission, Final Report.

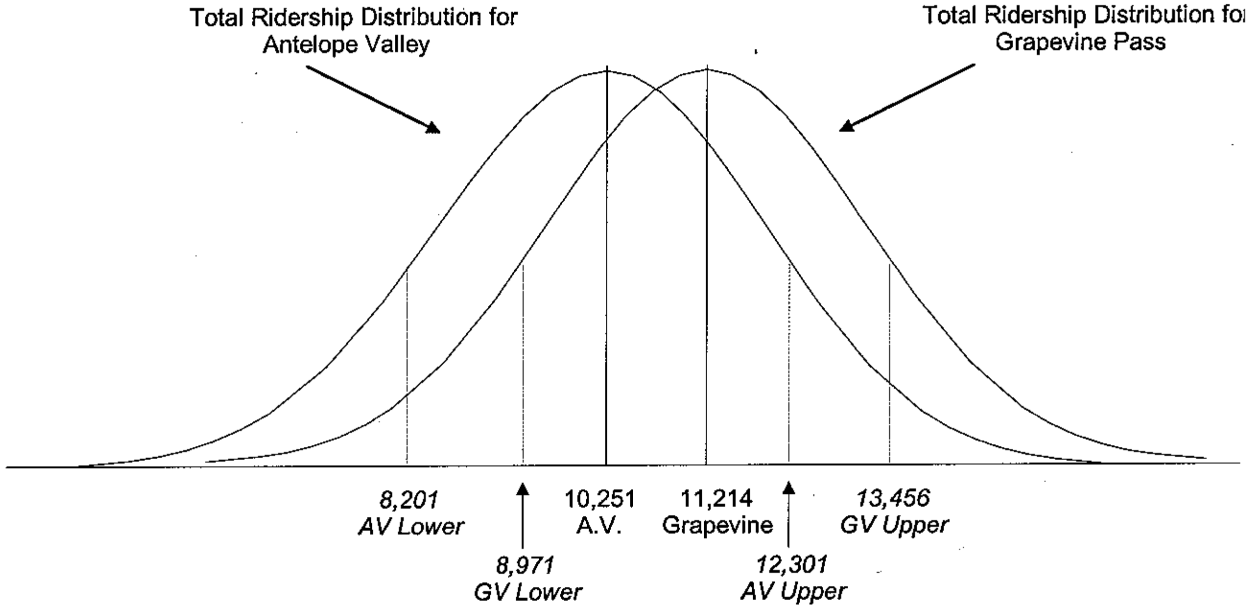
In terms of model results, and, given an approximate model error of approximately ± 20 percent, the ridership model is not sensitive enough to distinguish between demand estimates on different high speed rail alignments which vary by only 9 percent. And, within this range of confidence, there is a very real chance that ridership and revenue on the Antelope Valley alignment (i.e., SR-99 Long) could exceed that of the chosen SR-99 Base option (Exhibit E).

This model performance characteristic, while not allowing for the distinction between small changes from one alignment to the next, is useful for distinguishing across orders of magnitude. An example would be the differences in ridership and revenue found between the different HSR technologies. The model can distinguish between HS, VHS and Maglev technology because they have order-of-magnitude differences in demand. The model is therefore adequate for the principal purpose for which it was meant to be used.

In the case of VHS technology, the demand model predicts total ridership of 11.2 million passengers for the SR-99 Base alignment and 10.3 million passengers for the Antelope Valley (i.e., SR-99 Long) alignment – a difference of 8.6 percent. This estimated decline in ridership results in a drop of 10 percent in revenue (Exhibit D).

These percentages are well within the ± 20 percent error typically found in such models. This indicates that the difference in ridership and revenue are not statistically significant. The estimated difference in ridership and revenue for the Antelope Valley alignment is within the standard error for the entire model (Figure 0-1). Indeed, given the overlapping of the probability distributions around the base and Antelope Valley alignments, there is a significant likelihood that ridership on the SR-99 Long alignment may be higher than the SR-99 Base alignment.

Figure 0-1 - Upper and Lower Ridership Probability Limits for the Antelope Valley and Grapevine Alignments



Ridership in Thousands
VHS Technology
AV = Antelope Valley Alignment (SR-99 Long)
GV = Grapevine Alignment (SR-99 Base)

2.1.1 Induced Demand Estimation

One of the key features of high speed rail forecasting models is the estimation of "induced demand" (Exhibit G). Induced demand occurs when travelers take trips they would not otherwise have taken because of the introduction of a new transportation service. Without this new service, these individuals will either not have alternative means available or the alternatives which are available are too costly to justify the trip. Potential induced demand from high speed rail is therefore most likely to be driven by creating access to communities with limited or no alternative means of travel.

This is an area of demand estimation which is particularly important for communities in areas like the Antelope Valley. Currently, communities in the Antelope Valley rely heavily on the use of their cars for travel to San Francisco or Los Angeles or points between. Even airline trips to San Francisco would require a significant auto trip to access airports in Burbank or Los Angeles.

The ridership study estimates induced demand of 5 percent of total HSR demand (Exhibit G). Most studies show the impact of induced demand to be significantly higher than 5 percent -- more in the range of 30-50 percent. This could have a significant impact on both total ridership as well as ridership originating in communities which are more likely to be affected by the introduction of a "new" mode. The induced demand model is constrained by the definition of an inter city trip which is set to 80 miles or greater.[12] Adjusting this assumption would have a significant impact on induced demand estimates for the total rail line as well as for the Antelope Valley alignment.

Induced demand is highly correlated with distance, with longer travel distances generally having lower levels of induced demand. It is also highly correlated with the level of service associated with existing transportation alternatives. Since the trip length of induced trips is much shorter than the average length of intercity trips, it is likely that locations (such as Antelope Valley) near major urban areas will benefit most from a greater focus on induced demand.

The relationship between distance and induced demand is not fully accounted for in the current ridership study. Given the shorter distances to Los Angeles and the Bay Area from the Palmdale station (as opposed to LA or Santa Clarita to the Bay Area), it is probable that induced demand is higher for the Palmdale station than current estimates indicate. This is especially true given the lack of air service between the Antelope Valley and the Bay Area which means that HSR rail is even more likely to induce new trips from Antelope Valley than from elsewhere.

Moreover, with a better, faster, and more reliable mode of transportation, more Palmdale residents will seek employment in Busines districts such LA CBD. At the same time, LA residents will move Palmdale area while keeping their jobs in LA. Urban Economics theory implies that the improvement of transportation (short commuting time) leads residents of highly congested areas to relocate to less congested area.

2.1.2 Mode-Diversion Model Structure

Estimation of the amount of traffic diversion from each of the existing modes to HSR is carried out separately for each market segment. Individual mode diversion models are constructed for each of the existing modes (e.g., local air, private vehicle, conventional rail).

This structure does not represent a dynamic model which accounts for all the changes in demand and supply of transportation services. For example, the share of travelers that switch from a given existing mode to HSR may change if more than one choice pair is considered. Some travelers may switch from air to private vehicle if roads become less congested due to other auto travelers switching to HSR. The model does not capture this interaction across existing modes, it only captures the interaction between HSR and each existing mode one at a time. The impacts on distribution of travelers between modes (due to factors such as congestion) are not represented in the model as it currently stands.

The HSR share of total travel is very small (Exhibit G) and is therefore highly sensitive to the method of analysis and supporting assumptions. Even very small shifts from auto to HSR can have large impacts on HSR due to the overwhelmingly large share of auto. This leads to a second weakness of the mode diversion models in that congestion on existing modes is not considered. By 2015, congestion in auto and air will be high, especially around the larger metro

[12] The Palmdale distance to LA is 71 miles and is therefore not considered in the ridership analysis. Potential Antelope Valley riders are included in the Grapevine Pass alignment because the auto trip plus the rail trip to destinations north is greater than eighty miles.

areas (see Exhibit F). Increased congestion on existing modes which result in longer travel times and higher trip costs can induce more people to choose HSR. Table 0-1 illustrates the impact of a marginal change in assumptions regarding auto travel and trip definition in terms of total ridership.

Table 0-1 shows that trips greater than 80 miles in length are assumed to reach 106.8 million in 2015, with auto accounting for 76.9 percent of these trips. However, if road congestion is accounted for, the share of auto falls to, say, 72.9 percent, while the relative share of other modes rise. It is therefore highly probable that when congestion is accurately represented the ridership projections will increase significantly.

The impact of congestion is particularly acute for shorter distances such as the Palmdale to Los Angeles segment. Again, realizing that the 71 mile trip from LA to Palmdale is not considered in the base analysis, the predicted auto congestion for SR14 means that the Palmdale to LA HSR segment could attract even larger numbers of HSR travelers.[13] An outlying station such as Palmdale can also alleviate congestion on approaches to Los Angeles.

One of the major reasons for developing high speed train networks is to alleviate future congestion. The current ridership forecasts do not fully consider the impact of congestion on high speed train use. Other studies[14] have shown that future highway and airport congestion could increase HSR demand by 50 to 100 percent over no-congestion future year forecasts. Furthermore, since congestion is growing fastest in suburban and exurban areas, it is short intercity trips that benefit most from the provision of HSR. As a result, it is the short distance Antelope Valley-Los Angeles type of rail trips that will grow most rapidly in the future, increasing the role of HSR as a mechanism for maintaining regional mobility, by accommodating 50 to 80 mile intercity trip making.

[13] This is true even with HSR fares for Palmdale-LA. Like any travel choice, Antelope Valley riders will make the choice on the basis of the relative cost of the rail versus the auto. As the travel time spread between HSR and auto to LA increases with the expected congestion on SR14 more and more riders will choose the HSR mode.
[14] FTA, National Transit Report 1996, p.4.
U.S. DOT, High-Speed Ground Transportation For America September 1997, p 6-8.

Table 0-1 - Potential Impact of Congestion and Trip Definition on Trips by Mode - 2015

	Percent and Number of Trips by Mode				Total
	Auto	Air	HSR	Conv. Rail	
Trips (> 80 miles)					
- Percent Share	76.9 %	12.5 %	10.5 %	0.1 %	100.0 %
- Number of Trips (mn)	82.1	13.4	11.2	0.1	106.8
Trips (> 80 miles) with congestion					
- Percent Share	72.9 %	14.4 %	12.5 %	0.2 %	100.0 %
- Number of Trips (mn)	77.9	15.4	13.4	0.2	106.8
Trips (> 20 miles)					
- Percent Share	95.5 %	2.0 %	2.0 %	0.5 %	100 %
- Number of Trips (mn)	764.0	16.0	16.0	4.0	800.0
Trips (> 20 miles) with congestion					
- Percent Share	92.0 %	3.0 %	3.0 %	2.0 %	100.0 %
- Number of Trips (mn)	736.0	24.0	24.0	16.0	800.0

Note: Based on hypothesized alternative model specification.

2.1.3 Absence of Short Haul Intercity Trips in Trip Definitions

The ridership analysis includes only those trips greater than 80 miles in length which results in a large number of trips being dropped from the analysis (Exhibit Q). The exclusion of trips below 80 miles will underestimate total ridership volume. This is particularly true for the Antelope Valley alignment since it is less than 80 miles from Antelope Valley to Los Angeles (71 miles). Where a significant population center such as the Antelope Valley is within 80 miles of a national business center such as Los Angeles, large numbers of short haul trips are likely to be attracted to HSR. By excluding these short haul trips, the study was conservative, keeping its goal of developing a conservative estimate of overall ridership. Excluding short haul trips makes less sense when comparing different alignments.

It should also be noted that short haul trips are not necessarily all commuter trips. At a distance of 71 miles there will be business trips, trips to recreational and cultural attractions, and other trips. This will be especially true as the Antelope Valley grows and becomes more economically self sufficient.

2.1.4 Low Value of Access Time

The values of time derived from the different sources (i.e., the stated preference survey and base year calibration in the ridership study) are consistent with other studies with the exception of the value of time for access/egress. The literature dealing with the value of time shows that the value of access time should be in the range of 30 to 100 percent higher than the value of the line haul time.[15] In the current ridership study, this type of value was found only in the case of private

[15] *"Value of Time in Transportation Planning"*, Harrison and Quamby, ECMT, Paris, 1969 and

auto. This would suggest that the model would overstate an individual's willingness to drive to alternative stations if one was not located close at hand. This, coupled with the large size of zones (encapsulating 80 mile trips), would give model forecasts that suggest a greater willingness for Antelope Valley residents to drive to Bakersfield or Santa Clarita than would actually be the case. Correcting this would have the effect of lowering the ridership forecasts of the non-Antelope Valley options.

2.1.5 Transfer of Palmdale Passengers to Santa Clarita Station Overestimated

The analysis assumes that in the absence of a Palmdale station (i.e., SR-99 Base alignment), about 50 percent of the riders who would have boarded in Palmdale now board at Santa Clarita. This retention rate is considered too high given the level of road congestion between Palmdale and Santa Clarita. It should be noted that in high speed train travel, individuals will very seldom drive backwards to get to a train, particularly on congested roadways. Individuals from Palmdale going to San Francisco will drive to Bakersfield, not Santa Clarita. This is because on the homeward journey people will realize that if they had driven to Bakersfield they could be out of the train much earlier and driving the last leg home. This means that ridership and revenue for the non-Palmdale options will be somewhat lower than forecast given the assumption of access at Santa Clarita (Exhibit D).

In addition, the insignificant air-HSR modal constants suggests that travelers are likely to be indifferent between air and HSR when all else is equal. So, if access time is lower to LAX compared with access time to Santa Clarita, people from the Antelope Valley area will go by air and not by HSR to the Bay Area, further reducing the number of Palmdale boardings at Santa Clarita.

2.1.6 Size of Analysis Zones

Relatively large analysis zones have been specified so that access/egress times and cost are reflected with a limited degree of refinement. The large zone size assumes that all travelers within that zone face the same access/egress times and costs. However, this is not the case. Some travelers will face smaller times and costs relative to other travelers in the same zone. This can lead to overestimates of the number of travelers boarding at a given station. A smaller analysis zone for the Antelope Valley could result in larger ridership numbers for the Palmdale station compared to the other alignment.

The method used to assign stations within each zone may also overestimate the number of passengers boarding at a given station. Stations are determined using a logit model which includes individual station characteristics (e.g., station-to-station time, access/egress times, access/egress costs, frequency of service). In assigning a station to each zone, the station with the highest probability (from the logit model) is assumed to get all the passengers. For example, suppose a zone has three potential station choices – A, B and C. Based on the logit model, 57 percent of travelers choose A, 24 percent choose B and 19 percent choose C. The study picks the station with the highest probability (i.e., A), and then assumes all remaining passengers who

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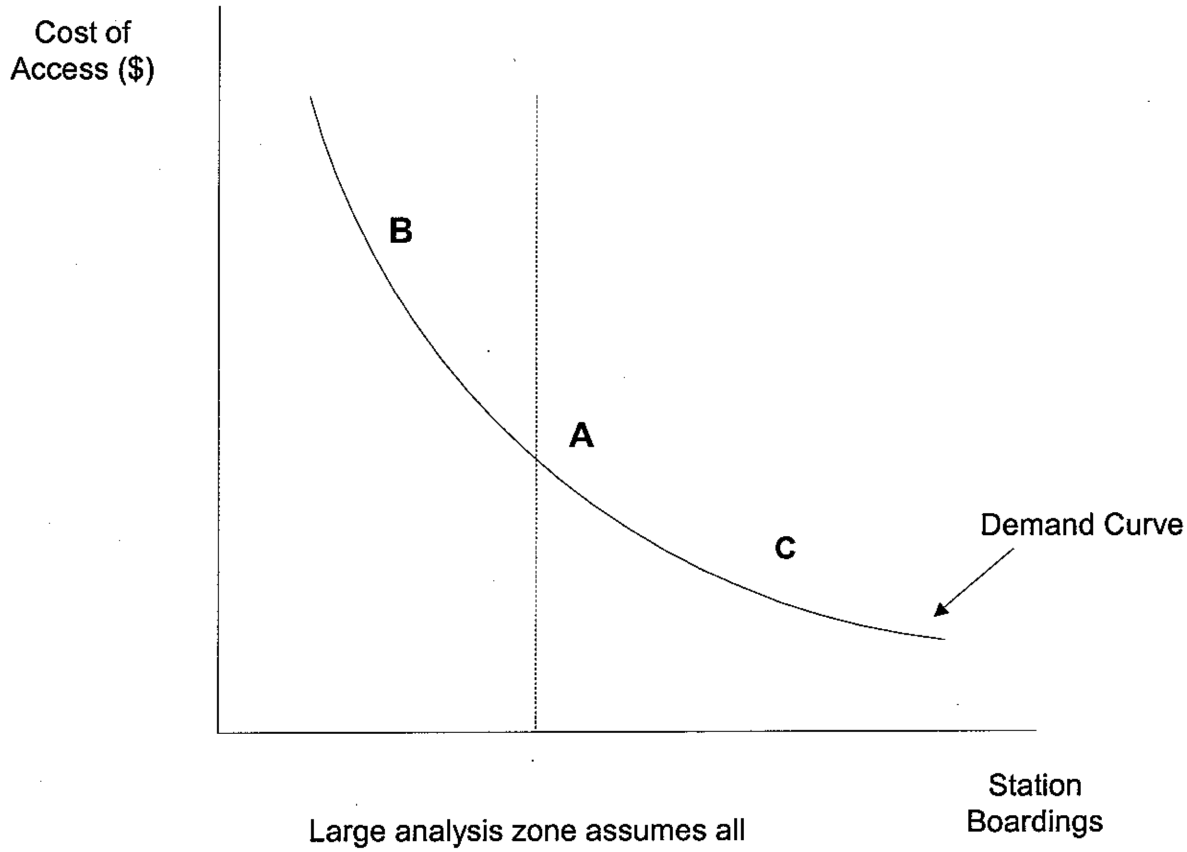
"*Analysis of Values of Time in the Toronto-Montreal Corridor for VIA Rail*", TEMS, Montreal, 1995 selected B and C will now travel through A. If A is now the only choice, passengers who originally selected B and C may change their travel plans or mode of transportation. Figure 0-2 illustrates this situation.

Figure 0-2 - Travel Demand within a Typical Analysis Zone



Large analysis zone assumes all travelers at A. Implies travelers at B and C not responsive to access cost.

2.2 Impact of Commuter Rail Potential on Alignment Choice

Although the Commission was tasked with an evaluation of intercity potential for high speed rail in California, there exists a real potential for a high speed commuter rail service once intercity rail service is established. The potential for high speed commuter service has been studied in a separate Commission study. This study looked at two "prototype routes" serving San Francisco and Los Angeles. The two routes serving Los Angeles were Bakersfield to LA with one route serving Palmdale station and the other going directly from Bakersfield to Santa Clarita[16].

The commuter rail study shows that the addition of the Palmdale station adds approximately one million passengers per year to the Bakersfield-LA direct routing through Santa Clarita. This represents an increase of 37 percent over the base potential commuter ridership from Bakersfield to LA. This ridership undoubtedly improves the financial and economic performance of commuter rail in southern California. Without the high speed rail link to Palmdale station for intercity trips this potential is lost.

2.3 Risk Analysis of Demand Projections

The above issues related to the Commission's ridership study have a direct impact on the analysis of the Antelope Valley alignment. Risk analysis makes it possible to model the way uncertainties about different components of ridership interrelate to effect the uncertainty of the difference in ridership between the two alignments. It is the difference in ridership that drives differences in benefits. Risk analysis thus makes it possible to determine whether preliminary estimates of uncertainty are sufficiently large to bring into question the recommended alignment. Risk analysis inputs, methods, and results (see Table 0-2) are described below.

Table 0-2 - Risk Analysis Inputs[17]

	Median	Lower 10%	Upper 10%
Through Ridership Change(thous.)	-634	-887.6	-380.4
Antelope Valley Origin-Termination (thous.)	919.5	613	1839
Percent of Antelope Valley Riders Retained (%)	25	5	50

This is an attempt to model the uncertainty of the net ridership gained or lost as result of potentially implementing the Antelope Valley alignment in place of the Grapevine alignment. It is based on modifications to the results of the ridership study and the assignment of probability ranges around those modified estimates. Median values for a variable represent what that variable is expected to be based on the discussion above. Lower and upper 10% values represent the endpoints of that range within which the value of the variable is 80% to certain to lie.

[16] High Speed Rail Corridor Evaluation by Parsons Brinkerhoff.

[17] Demand from Boardings/Alightings by Station, Preliminary Forecast.

The through ridership change refers to the difference in through riders (i.e., San Francisco--LA) which are expected as a result of the Antelope Valley alignment. These inputs are based on the median value for through riders lost due to the extra time required by the Antelope Valley route. The assumption in this analysis is that the median value is 50% less than the value in the ridership study. This assumption is based on the following considerations:

- Travel time values for small time savings are overestimated
- Time savings of less than 10 minutes are typically valued at one half the rate of larger time savings

The end points of the probability range are 40% greater or lower than the through ridership median. This reflects the many sources of general uncertainty identified in models of this type:

- Standard error of ridership projection models
- Sensitivity to mode diversion models and congestion
- Size of analysis zones

The estimate of Antelope Valley origins and terminations in the ridership model is quite conservative given the current and expected demographic and economic circumstances of the region. It is therefore treated as the low end of the probability range. The median value is 50% higher for the same reason. The high end of the probability range is double the median to represent the considerable upside potential for short haul and induced trips. These assumptions are based on the following considerations

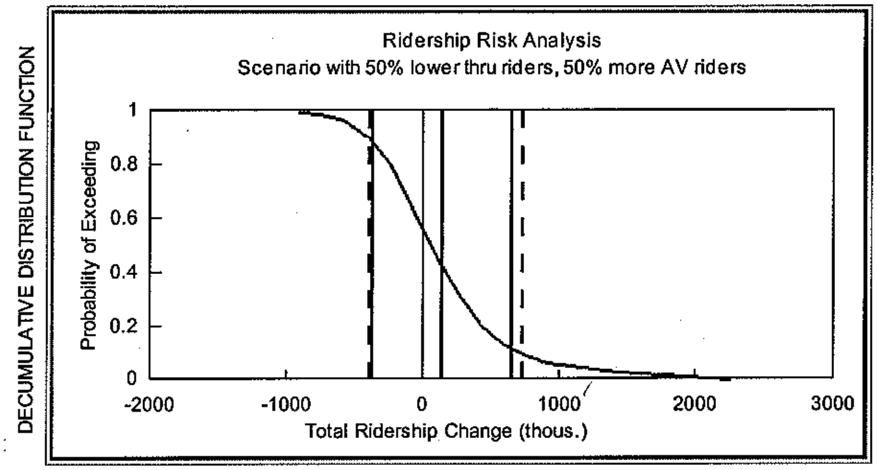
- Underestimation of induced demand
- Absence of short haul intercity trips
- Economic development impacts

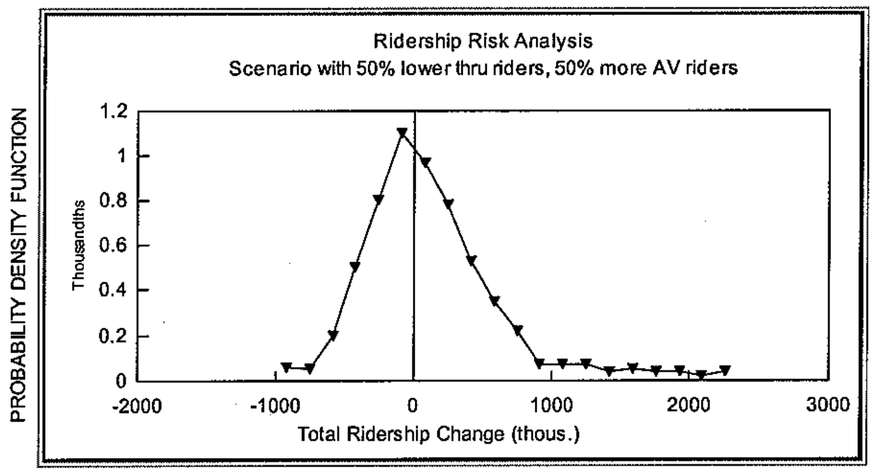
The ridership study estimates that 50% of riders who would utilize a Palmdale station would be retained by HSR at the Santa Clarita station if Antelope Valley is bypassed. This is treated as the high end of the probability range. The low end of the range is estimated to be 5% based on the real possibility that very few Antelope Valley riders would be retained. The median estimate is 25%. These assumptions are based on the following considerations:

- Tendency of potential rail users not to drive "backwards" to catch a train
- Congestion and access costs to Santa Clarita versus LAX
- Station choice methodology

When risk analysis is conducted with the above assumptions regarding ridership components, the result is a mean value of 128 thousand riders gained by implementing the Antelope Valley alignment. There is a probability of less than 10% that HSR would lose even half as many riders due to the Antelope Valley alignment as the ridership study suggests. The results are shown graphically below in Figure 0-3.

Figure 0-3 - Ridership Risk Analysis Results





Ridership Risk Analysis

Scenario with 50% lower thru riders, 50% more AV riders

TOTAL RIDERSHIP CHANGE (THOUS.)

Value	**Probability of Exceeding Value to the Left**
-828.17	99%
-543.97	95%
-409.99	90%
-256.49	80%
-149.82	70%
-47.83	60%
48.88	50%
157.21	40%
279.20	30%
440.26	20%
716.36	10%
1142.34	5%
2023.49	1%

Mean = 128.23 **Std. Dev.=511.70**